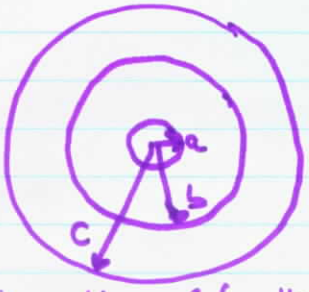
HW 4

$$D_r(r) = \frac{Q}{4\pi r^2}$$

① 

For inner location (from HW3)

$$V(a) = \frac{\rho_s a^2}{\varepsilon_0}\left(\frac{1}{b}-\frac{1}{c}\right) + \frac{\rho_s a^2}{\varepsilon}\left(\frac{1}{a}-\frac{1}{b}\right)$$

$$= \frac{\rho_s a}{\varepsilon_0}(.228)$$ using #5

For outer location (from HW3)

$$V(a) = \frac{\rho_s a^2}{\varepsilon}\left(\frac{1}{b}-\frac{1}{c}\right) + \frac{\rho_s a^2}{\varepsilon_0}\left(\frac{1}{a}-\frac{1}{b}\right)$$

$$= \frac{\rho_s a}{\varepsilon_0}[.6055]$$ using #5

$$Q = \rho_s 4\pi a^2 \Rightarrow \rho_s a = \frac{Q}{4\pi a}$$

outer

$$V(a) = \frac{Q}{4\pi a \varepsilon_0}[.6055]$$

$$Q = \underbrace{\frac{4\pi a \varepsilon_0}{.6055}}_{C_{outer}} V(a)$$

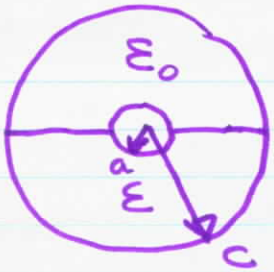
$$C_{outer} = \frac{4\pi a \varepsilon_0}{.6055}$$

inner

$$V(a) = \frac{Q}{4\pi a \varepsilon_0}[.228]$$

$$Q = \underbrace{\frac{4\pi a \varepsilon_0}{.228}}_{C_{inner}} V(a)$$

$$C_{inner} = \frac{4\pi a \varepsilon_0}{.228}$$

2. 

Can either assume ε or $\varepsilon = 4\varepsilon_0$ in bottom half

Capacitance of coaxial cable is

$C = \frac{2\pi\varepsilon}{\ln c/a}$ if the region is filled uniformly

However, it is half filled with each dielectric

$$\Rightarrow \quad C = \left(\frac{2\pi\varepsilon_0}{\ln c/a}\right)\frac{1}{2} + \left(\frac{2\pi\varepsilon}{\ln c/a}\right)\frac{1}{2}$$

$$= \frac{\pi(\varepsilon_0+\varepsilon)}{\ln c/a}$$

Note that we recover the same capacitance if ε or ε_0 fills the region between the conductors

3. See Spreadsheet

4. Capacitance of <u>two wire line</u>

Dimensions for experiment (yours may differ)

$\ell = .12$ m (wire length)

a = wire radius

$\varepsilon_r \simeq 2$ (approx)

D = 2 x insulation thickness

$\frac{D}{a} \approx 3$

Two Wires

Approx formula

$$C = \frac{\pi\varepsilon\ell}{\ln(D/a - 1)} \simeq 9.6\,pF$$

More Exact

$$C = \frac{\pi\varepsilon\ell}{\ln\left(\frac{D}{2a} + \sqrt{\left(\frac{D}{2a}\right)^2 - 1}\right)} \simeq 6.9\,pF$$